

**Impact of Levee Cutoff Walls on
Groundwater Recharge**

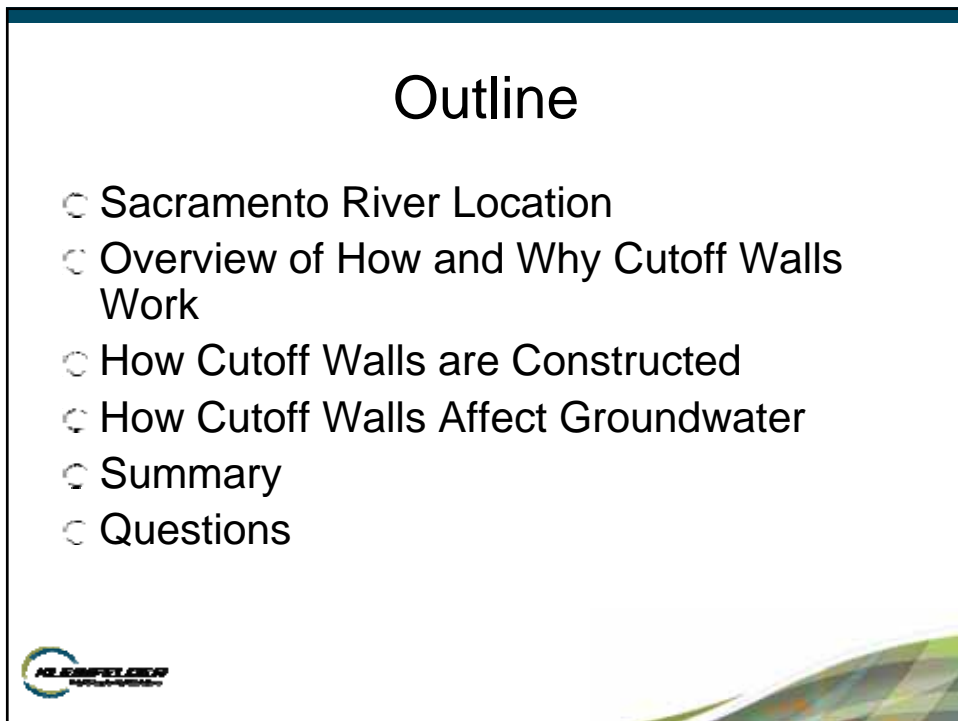
Presented By:
Paul Sorci, PE



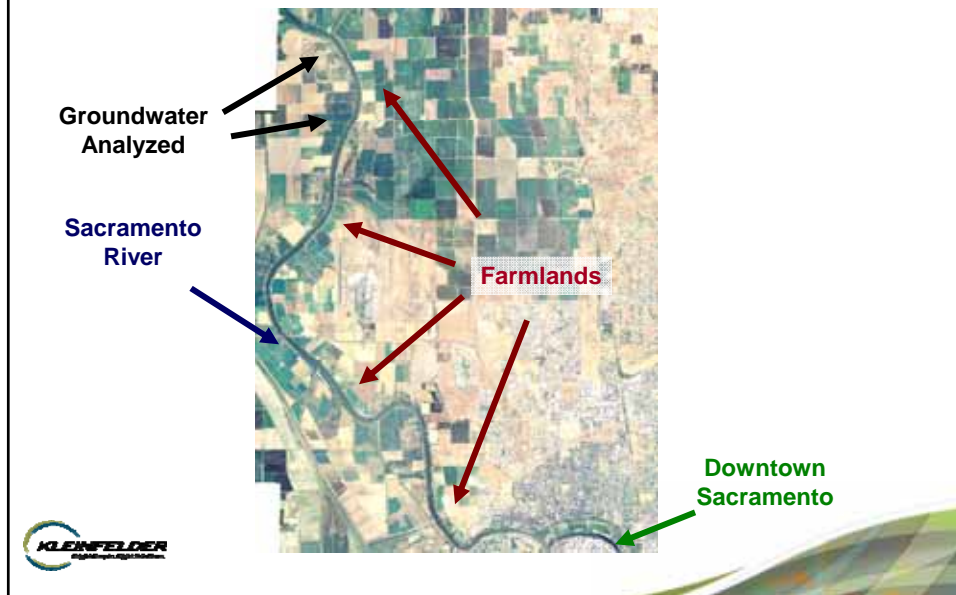


Outline

- Sacramento River Location
- Overview of How and Why Cutoff Walls Work
- How Cutoff Walls are Constructed
- How Cutoff Walls Affect Groundwater
- Summary
- Questions



Sacramento River Location

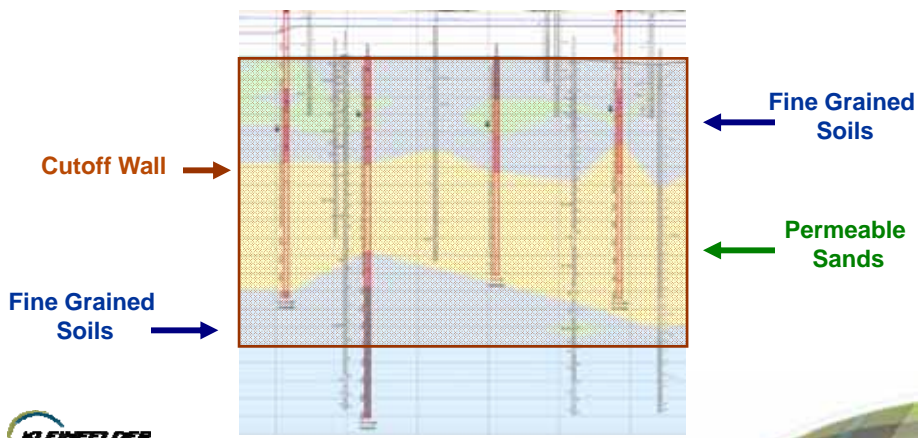


Overview of Cutoff Walls

- How They Work
 - Creates a nearly impermeable vertical element that stops water from traveling horizontally through permeable layers
 - Lowers the amount of pore pressure at the landside levee toe due to high water levels

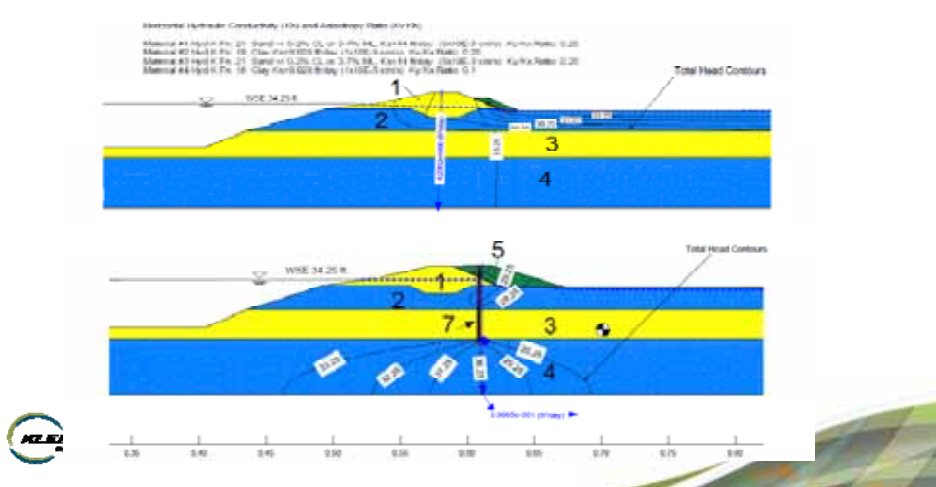
Overview of Cutoff Walls

How They Work



Overview of Cutoff Walls

How They Work



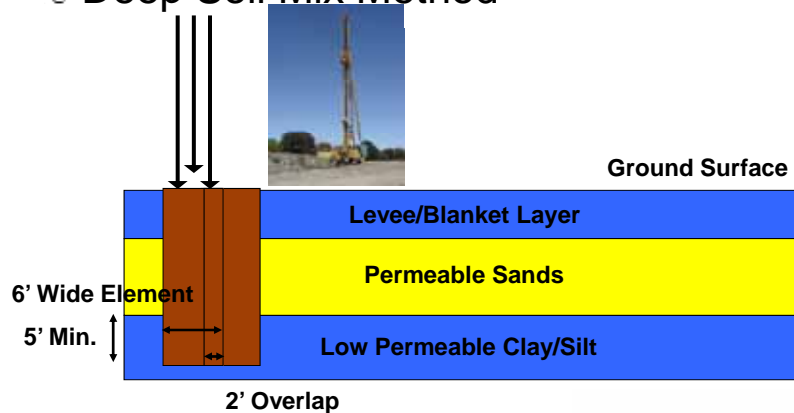
Overview of Cutoff Walls

- Multiple Methods of Installation in Natomas
 - Deep Soil Mixing
 - Slurry Trench Method



Cutoff Wall Construction

- Deep Soil Mix Method



Cutoff Wall Construction

○ Deep Soil Mix Method



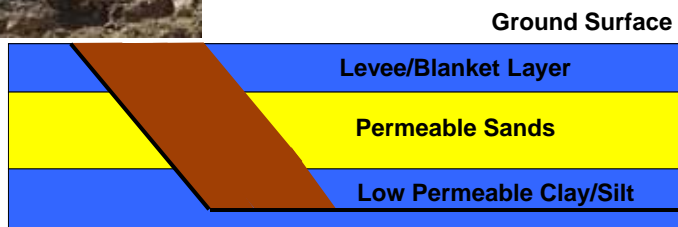
Cutoff Wall Construction

○ Deep Soil Mix Method



Cutoff Wall Construction

○ Slurry Trench Method



Cutoff Wall Construction

○ Slurry Trench Method



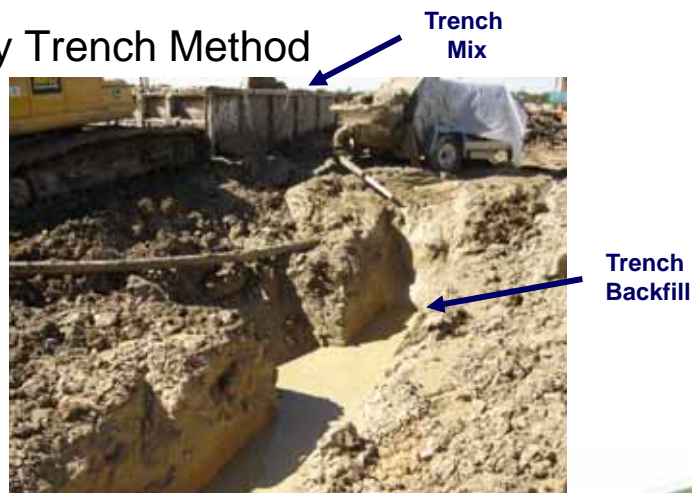
Cutoff Wall Construction

○ Slurry Trench Method



Cutoff Wall Construction

○ Slurry Trench Method



Cutoff Wall Construction

- Compare and Contrast
 - DSM
 - Mixes in situ soils – less spoils
 - Smaller construction footprint – less equipment
 - Slurry Trench
 - Allows engineer to see material wall is keying in
 - Better quality control



Groundwater Affects

- Problem
 - Soil bentonite (cutoff) walls will reduce groundwater recharge to landside of levee
 - Perform seepage analysis to evaluate
 - Estimate groundwater flow with and without cutoff wall in place
 - Estimate effect of nearby canals on groundwater recharge



Groundwater Affects

- Two Types of Analysis
 - Steady State
 - Transient
 - Did not account for 3-D effects i.e. flow around edges of cutoff wall
 - Use hydrograph to perform transient analysis



Groundwater Affects

- Parameters Selected
 - Permeability Modeled as 10^{-6} cm/sec
 - Stratigraphy Different at Sections
 - Wall extends 5 feet into fine grained foundation
 - Material beneath wall either sand or clay depending on stratigraphy
 - Cutoff wall less effective when sand beneath wall



Groundwater Affects

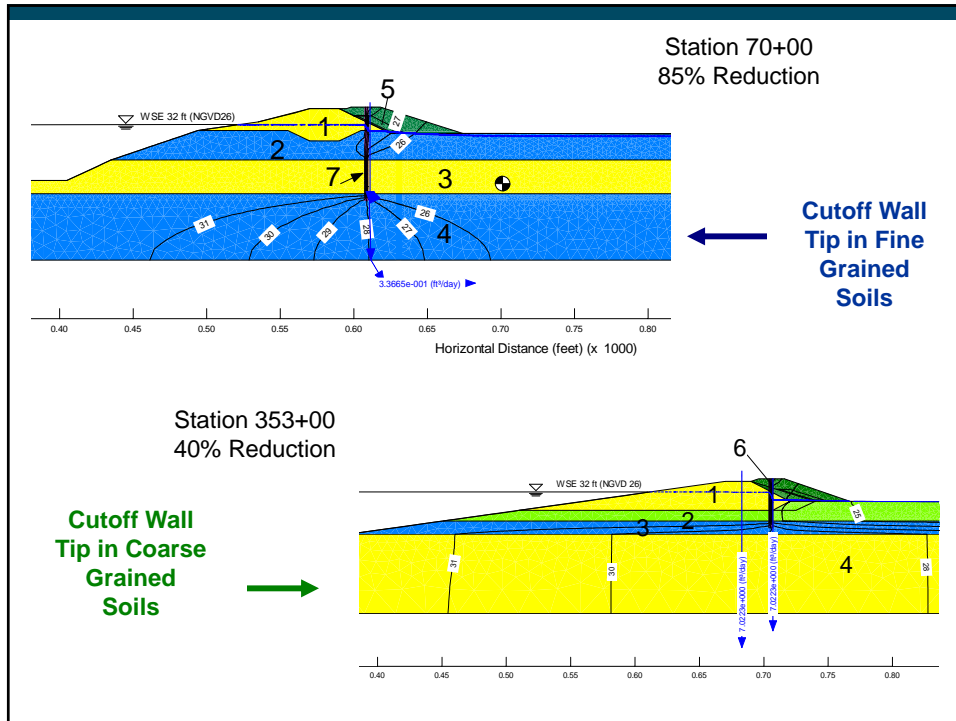
- Steady State Seepage Analysis
 - Stations 70+00 cutoff wall fully penetrates sand layer
 - Station 353+00 cutoff wall only partially penetrates sand layer
 - Aquifer only recharges when river level above groundwater level



Groundwater Affects

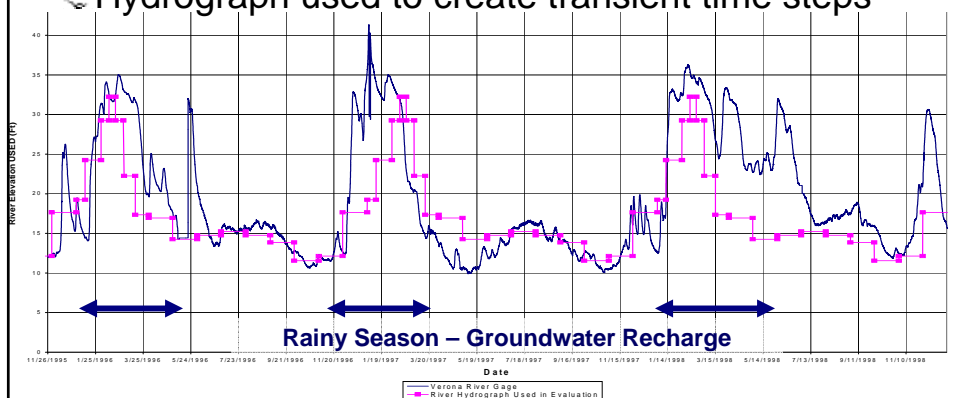
- Steady State Seepage Analysis (cont)
 - Cutoff wall reduces seepage quantities up to 85 percent when sand layer is fully penetrated (Station 70+00)
 - Cutoff wall reduces seepage quantities up to 40 percent when sand layer is partially penetrated (Station 353+00)





Groundwater Affects

- Transient Seepage
 - Verify and validate steady state seepage
 - Hydrograph used to create transient time steps



Groundwater Affects

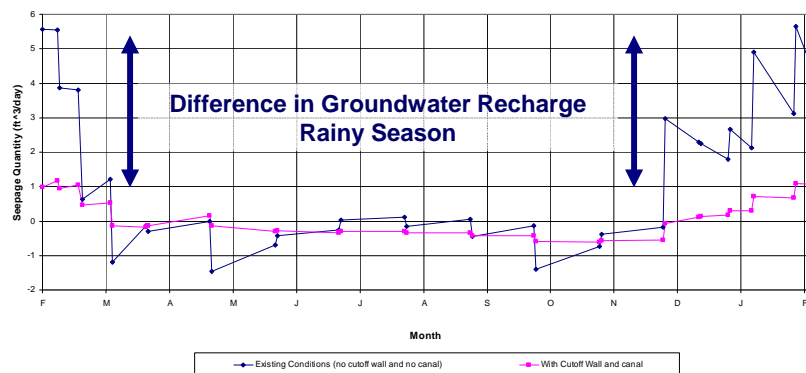
- Transient Seepage
 - Analysis performed where sand layer is fully penetrated (Station 70+00)
 - Highest reduction in groundwater seepage
 - Cutoff wall reduces seepage quantities up to 70 percent, as compared to 85 percent for steady state seepage
 - Steady state seepage can conservatively approximate the effect of the cutoff wall



Groundwater Affects

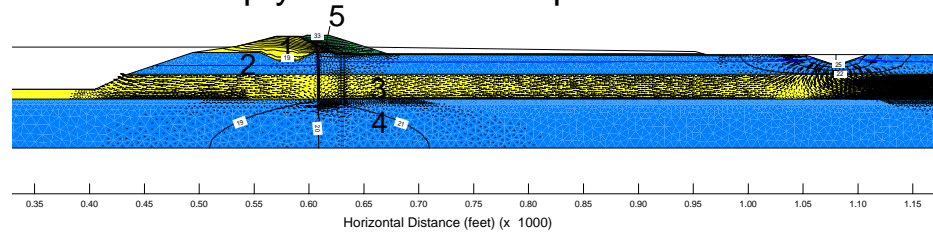
- Overall, the cutoff wall will reduce groundwater aquifer recharge by about 20-25 percent
- Effect may be lower due to 3-D flow

Cutoff Wall Impact on Seepage Quantities



Groundwater Affects

- Canals
 - Canal modeled about 800 feet from landside toe of levee
 - Time dependent boundary condition
 - Canal contained 5 feet of water from May to November
 - Canal empty December to April



Groundwater Affects

- Canals
 - Minimal impact of canal on groundwater elevations
 - Groundwater around cutoff wall increases in summer months
 - Due to water flow in canal and decrease of recharge to aquifer from the cutoff wall

Summary

- Cutoff Walls
 - Creates a nearly impermeable vertical element that stops water from traveling horizontally through permeable layers
 - Have been installed using a Deep Soil Mixing or Slurry Trench Method in Natomas Basin



Summary

- Groundwater Affects
 - Steady state conservatively estimates recharge quantities
 - Locally, areas may see reduction in recharge up to 85 percent
 - Overall, recharge reduced 20 to 25 percent
 - Cutoff wall could impede seepage to river during summer months
 - Canal and cutoff wall may locally increase groundwater levels in summer months



Questions ?

